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News From Argonne's Transportation Technology R&D Center

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VIEWPOINT

Argonne Hosts Chinese-American Olympics Planning Group

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RESEARCH REVIEWS

New Hydrogen Supply System Adds Unique Testing Capabilities to Argonne's Advanced Powertrain Research Facility

Many experts believe that hydrogen is the fuel of the future, but what if you are trying to test a hydrogen-powered vehicle *today*? Finding a reliable and precisely metered supply of the gas for evaluating hydrogen-powered fuel cells and internal combustion engines fueled by hydrogen has been a bit of a challenge – until now. Researchers across the United States and the world will now have access to an advanced hydrogen delivery and metering system recently installed at the Advanced Powertrain Research Facility (APRF) located at Argonne National Laboratory. *Page 4*



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Argonne Is Part of a Team Selected to Develop Advanced Combustion Technology for Vehicles

A research team comprising industry, university, and national laboratory innovators — including Argonne — was awarded a \$14.5 million research project to develop high-efficiency, clean combustion technology for vehicles. The project was one of 12 selected from a solicitation by the U.S. Department of Energy's (DOE's) Office of Energy Efficiency and Renewable Energy, FreedomCAR and Vehicle Technologies Program. Seven of the projects will develop enabling technologies, components, methods, and fuels for high-efficiency, clean combustion. The remaining five projects will develop technologies to convert waste heat from engines to electrical or mechanical energy — improving overall thermal efficiency and emissions reductions. *Page 5*



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Advances Have Made Alternative-Fuel Use Nearly "Invisible"

Today's alternative-fuel vehicles are virtually indistinguishable from their gasoline-fueled counterparts in the ways they handle, look, and drive. Argonne's Center for Transportation Research remains at the forefront of AFV research. *Page 6*

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Argonne Hosts Chinese-American Olympics Planning Group

In November, Argonne's Transportation Technology R&D Center hosted approximately 90 Chinese and American scientists and policy makers working toward the goal of a cleaner Beijing. The December gathering was the first American meeting of the Chinese-American Joint Working Group on Olympic Cooperation to develop sustainable technologies for the City of Beijing and the 2008 Olympic Games. Two previous meetings had been held in



The Chinese members of the Joint Working Group on Olympic Cooperation for the City of Beijing and the 2008 Olympic Games delegation gather for a photo during their meeting at Argonne National Laboratory. Above, Beijing Vice Mayor Fan Boyuan test drives a Ford Escape hybrid vehicle.



China. "We have already cleaned emissions from factories and cars and are planting more trees for a cleaner environment," said Fan Baoyuan, Beijing's Vice Mayor.

The Joint Working Group was created about two years ago by the U.S. Department of Energy (DOE), China's Ministry of Science and Technology, and the Beijing Municipal Government. As part of its bid to host the 2008 Summer Games of the XXIX Olympiad, Beijing is committed to improving its environmental quality to create green Olympic Games.

The Joint Working Group is charged to promote clean, efficient energy technologies in Beijing and in China. "Helping create a cleaner China helps the entire world," explained Argonne's Transportation Technology R&D Center Director Larry Johnson, who is a member of the Joint Working Group.

Argonne hosted the American meeting of the Joint Working Group. DOE leads the American team, with representatives from the departments of Agriculture, Commerce, and State; the Environmental Protection Agency; and others. The Chinese delegation included representatives from several agencies of the Beijing Municipal Government, China's Ministry of Science and Technology, Tsinghua University, and the China Automotive Technology and Research Center. Representatives from the Chinese Consulate General in Chicago also attended the meeting. Visitors toured Argonne's world-class transportation research laboratories, including fuel cell facilities and vehicle and engine testing laboratories, as well as the Advanced Photon Source, this hemisphere's brightest source of X-rays for research.

During the meeting, Chinese officials presented a progress report on the Olympics and gave a preliminary plan for energy, environment, and transportation. A representative from the 1996 Atlanta Olympics shared lessons learned. Attendees also rode in advanced vehicles, including a GM Allison hybrid bus, Daimler-Chrysler GEM neighborhood electric cars, and a Ford Escape hybrid.

Working groups developed plans to work together in the following areas:

- Natural Gas Technology and Infrastructure Development;
- Fuel Cells, Hydrogen and Electric Vehicles;
- Green Building Design and Construction;
- Alternative Transportation Technologies;
- Air Quality Management;
- Water Quality Management;
- Clean Coal; and
- The Beijing-Chicago Friendship Cities Initiative.

During the visit, Argonne officials also formalized plans to work with China to develop liquefied natural gas power systems for sanitation trucks.



Fan Boyuan and others involved in the Olympics planning meeting discuss the advantages of hybridization after riding in GM Allison's hybrid transit bus.



Fan Baoyuan, Beijing Vice Mayor, addresses attendees at the first American meeting of the Chinese-American Joint Working Group on Olympic Cooperation.



New Hydrogen Supply System Adds Unique Testing Capabilities to Argonne's Advanced Powertrain Research Facility

Many experts believe that hydrogen is the fuel of the future, but what if you are trying to test a hydrogen-powered vehicle today? Finding a reliable and precisely metered supply of the gas for evaluating hydrogen-powered fuel cells and internal combustion engines by hydrogen has been a bit of a challenge – until now.

Researchers across the United States and the world will now have access to an advanced hydrogen delivery and metering system recently installed at the Advanced Powertrain Research Facility (APRF) located at Argonne National Laboratory. The APRF is the U.S. Department of Energy's (DOE's) principal research facility for assessing advanced fuel cell and hybrid electric vehicle technologies for the DOE FreedomCAR and Vehicle Technologies Program.

The manager of the project is Henry Ng, who said, "The hydrogen feed system significantly increases the capabilities of Argonne's APRF. It is now the only facility in the United States and just the second in the world equipped for dynamometer testing of all types of hydrogen vehicles, including those with 4-wheel drive."

One of the biggest challenges, added Ng, was to ensure that the new supply system could provide — on demand — a large volume of hydrogen to a test vehicle's engine and do so in precisely measured quantities to meet the real-time performance requirements for the aggressive acceleration required during certain emissions tests. The solution the engineering team developed was to use two separate, ultra-precise flowmeters to cover a very wide dynamic flow range: one meter for lower flow rates and the other for when higher gas volumes are required. The design permits the system to accept up to 500 pounds per square inch gauge (psig) of hydrogen from the storage tanks outside the APRF and then accurately deliver the gas to the test vehicle at pressures of 75–125 psig. This is all accomplished with the capability of metering the gas down to a fraction of a gram at 10-Hz data cycles.

One of the first hydrogen-powered vehicles to take advantage of the new hydrogen supply system was a modified Ford Explorer with a hydrogen-powered internal combustion engine. The Explorer's hybrid powertrain was developed by Texas Tech University for the DOE's FutureTruck student engineering competition. The hybrid electric vehicle uses a 2.3-L, 4-cylinder engine taken from a 1986 Mustang and modified to use gaseous hydrogen instead of liquid gasoline. APRF's new hydrogen feed system was instrumental in helping the students put the vehicle through its paces on the test stand.

APRF's development of the hydrogen gas supply system is entirely funded by DOE's FreedomCAR and Vehicle Technologies Program. Companies and organizations can request access to conduct their own testing in this unique user facility.



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Top: Dave Shimcoski checks the hose connecting the Advanced Powertrain Research Facility's new hydrogen supply system to a test vehicle as Geoff Amann (center) and Henry Ng look on. Bottom: Closeup of the APRF's new hydrogen supply system.

Argonne Is Part of a Team Selected to Develop Advanced Combustion Technology for Vehicles

In 2001, the United States used more than 10 million barrels of crude oil per day for passenger and commercial vehicles. Over half of that oil was imported from foreign countries. Current projections reveal that imports will fulfill about 70% of domestic needs by the year 2025. Increasing the energy efficiency of our nation's passenger and commercial vehicles is an effective way to reduce dependence on imported oil while also reducing environmental emissions.

A research team comprising industry, university, and national laboratory innovators — including Argonne — was awarded a \$14.5 million research project to develop high-efficiency, clean combustion technology for vehicles. Other members of the team, which is led by International Truck and Engine Corporation (ITEC) in Warrenville, Illinois, include Ricardo, Borg-Warner Turbo, Jacobs Vehicle Systems, Siemens, Mahle, Lawrence Livermore National Laboratory, University of California-Berkeley, and Conoco-Phillips. The project was one of 12 selected from a solicitation by the U.S. Department of Energy's (DOE's) Office of Energy Efficiency and Renewable Energy, FreedomCAR and Vehicle Technologies Program. The 12 projects have a total value of \$175 million (with 50%, or \$87.5 million, contributed by the private sector). Seven of the projects will develop enabling technologies, components, methods, and fuels for high-efficiency, clean combustion. These projects have shown potential to achieve efficiency goals for cars and trucks while maintaining cost and high durability with near-zero emissions. The remaining five projects will develop technologies to convert waste heat from engines to electrical or mechanical energy — improving overall thermal efficiency and emissions reductions.

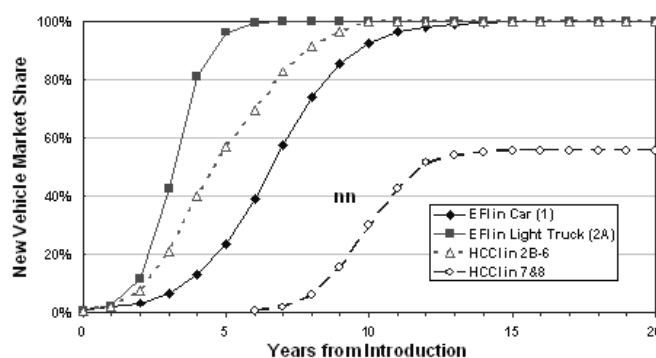
In the project involving Argonne, ITEC will conduct research to enable the development and application of homogeneous-charge compression-ignition (HCCI) combustion over as large an operating range as possible by integrating commercial or near-commercial fuel, air, and engine technologies with advanced controls. The goal is to develop a low-emissions technology that will be both less costly and more fuel-efficient than lean nitrogen oxide traps (LNT) (fitted to present diesel engines and assumed to be the leading candidate technology). The HCCI-based technology package is expected to cost \$2,000 less than an LNT-based technology and realize a 12% reduction in fuel consumption relative to LNTs.

Argonne will evaluate the cost-effectiveness and market potential of the engine technology, taking into account cost and performance attributes developed by the study team. Researchers will adapt several existing models to the needs of the project:

- The VISION model will be used to translate sales predictions for the ITEC technology into disaggregate fleet

aggregate national fuel consumption and emissions from the disaggregate submodels developed.

- The GREET (Greenhouse Gas, Regulated Emissions and Energy Use in Transportation) model will be used to construct per-vehicle full fuel-cycle emissions and fuel consumption, focusing on net crude oil consumption.
- The AVID (Advanced Vehicle Introduction Decisions) model will be used as a starting point for market share predictions.



Prior analogous technology (electronic fuel injection) and illustrative projected HCCI introduction paths (estimated year of introduction in the ITEC engine manufacturing plant is 2010 — “year 1”)

The diverse commercial truck and bus market served by ITEC will require each of these models to be adapted to the specific market segment, including pickup trucks, urban delivery straight trucks, school buses, and combination trucks. Within each of these categories, there are several truck body configurations. Argonne researchers will study the fuel-use patterns and sales rates of each truck-type category and will characterize available competing technologies to develop estimates of first-cost differentials and fuel savings.

Primary performance measures will be used to estimate differences in initial cost, fuel consumption, and emissions of the ITEC HCCI technology developed from the research against known, competing technologies. Secondary performance measures will be used to track total national oil use reduction and emissions changes. The HCCI technology will be demonstrated in a commercial diesel engine.

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Advances Have Made Alternative-Fuel Use Nearly “Invisible”

Stories circulating about how different it is to drive Toyota’s Prius hybrid-electric car may have you thinking that the relatively minor differences would be only magnified once you got inside an alternative-fuel vehicle that ran on compressed natural gas (CNG) or an ethanol (E85) or biodiesel (B20) blend. Yet today’s AFVs are virtually indistinguishable from their gasoline-fueled counterparts in the ways they handle, look, and drive. This is particularly true of biodiesel- and ethanol-fueled vehicles, which typically don’t even carry identifying decals above their back bumpers.

“Use of ethanol is entirely invisible to the user,” notes Paula Mann, who is Fleet Coordinator for Argonne’s (ANL’s) Plant Facilities and Services (PFS) Division. According to Mann, Argonne operates a fleet of 56 alternative-fuel vehicles, including 8 CNG vehicles (3 vans and 5 pickup trucks), 8 bi-fuel CNG/gasoline vehicles (5 pickups and 3 vans), and 40 E85 (ethanol, gasoline, or an 85/15% mixture of the two) flex-fuel vehicles (39 vans and 1 pickup). Argonne is considering using biodiesel in its diesel-fueled fleet, but certain technical details need to be worked out first. Biodiesel (B100) is a clean-burning alternative fuel produced from domestic renewable resources. It is often used as a blend consisting of about 20% biodiesel and 80% diesel fuel (B20).

Because there are no commercial alternative-fuel stations nearby, Argonne maintains its own refueling stations for CNG and E85. Refueling a vehicle with E85 is identical to refueling with gasoline, but that’s not true of CNG. “Safety glasses are recommended with CNG,” explains Ken Albert, a PFS employee, “because it is pumped at a pressure of 2,700 psi. For that reason, you need to be careful to seat the valve correctly before turning on the gas flow.” The CNG refueling facility is capable of filling a CNG tank in about the same time it takes to fill your car’s gasoline tank.

Albert drives a Ford F150 pickup that’s been converted to CNG. “There is a slight hesitation in cold or wet weather until the engine warms up,” Albert says, “but then the F150 drives exactly like a standard pickup.” The F150 has a small CNG decal above the back bumper, and the CNG tank rides in the far end of the cargo bed, but from a distance, it is indistinguishable from an ordinary pickup truck.

Argonne maintains the AFV fleet in support of its scientific and engineering missions and to keep Argonne in compliance with the Energy Policy Act of 1992, which mandates that fleet owners stock their fleets with specified percentages of AFVs. The AFV fleet was larger in past years, when Argonne participated in a research and demonstration program that was

established to comply with the federal fleet mandates of the Alternative Motor Fuels Act (AMFA), which directed the U.S. Department of Energy (DOE) to purchase AFVs, use them in federal fleets, and collect data on them. At the height of the effort, Argonne’s Center for Transportation Research (CTR) maintained the largest demonstration center in the AMFA program. Data collection focused on vehicle drivability, reliability, and fuel efficiency, along with other operating characteristics, such as emissions and performance under varying weather conditions. The research program ended in 1995. Argonne’s fleet of AFVs was greatly reduced in 1997 as a cost-saving measure.

The CTR remains at the forefront of AFV research. The drive toward a hydrogen economy is motivating much of the research in this area. The CTR is working on several promising technologies aimed at providing a smooth transition from today’s gasoline-powered internal combustion vehicles to hydrogen-powered vehicles using fuel cells. As a part of that effort, DOE recently awarded a \$3.6 million multiyear contract to Argonne and other expert organizations to analyze the hydrogen production and delivery infrastructure as a complex adaptive system by using an agent-based modeling and simulation (ABMS) technique.

Argonne’s expertise in alternative fuels was also recently recognized by the China Automotive Technology and Research Center (CATARC), which signed a groundbreaking memorandum of understanding that makes it possible for Argonne and CATARC to exchange information on the commercialization of energy-efficient vehicle technologies and clean transportation fuels in China.



Ken Albert, of the Plant Facilities and Services Division, refills his truck at Argonne’s CNG refueling facility.

Michael Thackeray, Materials Research Group Leader in Argonne's Chemical Engineering Division, was recognized on April 5 in Pretoria, South Africa, where a street in The Innovation Hub, Africa's first internationally accredited science park, was named in his honor. Thackeray was one of 11 notable South African scientists and innovators — including four Nobel Prize winners and two astronauts — to be honored with his own street name during a ceremony celebrating the successes of South African-born or -educated scientists, innovators, and entrepreneurs — especially those who are internationally recognized — to “provide strong motivation for those who are themselves battling to be recognized for their inventions and innovations.” Thackeray is perhaps best known for his research on electrode materials for lithium batteries; the technology he developed helps power everyday objects like cellular telephones. Thackeray was born in Pretoria and graduated from the University of Cape Town. He came to Argonne in 1994. He said his return trip to South Africa was especially heartwarming because the country was making great strides forward, despite its racially divided and volatile past. Thackeray said, “Through the leadership of previous presidents Nelson Mandela and F.W. DeKlerk, who negotiated a remarkably peaceful transition of political power a decade ago, the people have come together in a really positive way. Science and technology have historically been rooted in the white community of South Africa. Now there's a tremendous impetus to train the next generation of all South Africans.” Thackeray added, “My feeling is that in this whole process, one has to build on the strengths of the past.” His words are echoed in the new signposts at the science park, raised both to honor those who have led the way in South African science and technology and to inspire the innovators of the future.



Michael Thackeray

Bill Ellingson, of Argonne's Energy Technology Division, has been honored by the National Aeronautics and Space Administration (NASA) for his work on ceramic composite components. Ellingson and colleagues from DOE and Oak Ridge National Laboratory were the recipients of NASA's Turning Goals into Reality Award. The award celebrates the year's most significant accomplishments that add to the NASA legacy and honors recipients for their contributions to the advancement of aviation and space technology. Ellingson

and his colleagues developed nondestructive inspection methods and protocols for ceramic engine components. These inspections, called health or condition monitoring, can help determine whether these components, which can cost \$100,000 per part, are still functioning properly or if they need to be repaired or replaced. This is not the first award Ellingson has received for this project. He was also recognized in 2001 with a Research Partnership Award from DOE.

A presentation by **Chris Powell**, of Argonne's Energy Systems Division, entitled “X-Ray Absorption Measurements of Diesel Sprays and the Effects of Nozzle Geometry,” presented at the 2004 Society of Automotive Engineers (SAE) Fuels and Lubricants Meeting and Exhibition at Toulouse, France (June 8–10, 2004), was recognized by SAE for Excellence in Oral Presentation.

A paper presented by Argonne's **Steve Ciatti**, **Chris Powell**, and **Franz Tanner**, entitled “Comparison of X-Ray-Based Fuel Spray Measurements with Computer Simulation Using the Cab Model,” was judged to be the best paper presented at the American Society of Mechanical Engineers spring technical conference in Kyoto, Japan. The three were presented with a plaque during the banquet program at the ASME fall technical conference in Long Beach, California, on October 26.

The research of Argonne's **Kyeong Lee** and others in developing a three-dimensional technique to examine the structure of nanoparticles emitted by diesel engines was featured in *Small Times Magazine* in March. In the article, Lee and **Raj Sekar** explain that “the detailed information on particulate size, structure, and chemistry obtained by using the new method gives a better understanding of potential health effects.”

The New York Times interviewed **Bob Larsen**, of Argonne's Center for Transportation Research, at the recent Hybrid Vehicle Technology Symposium of the Society of Automotive Engineers in Costa Mesa, California. Larsen, along with **Michael Wang**, also of Argonne's Center for Transportation Research, was also interviewed by the Times of Indiana regarding the use of ethanol as a fuel and by Consumer Reports for a story on plug-in hybrids.



Industrial technology development is an important way for the national laboratories to transfer the benefits of publicly funded research to industry to help strengthen the nation's technology base. The stories highlighted in this issue of *TransForum* represent some of the ways Argonne works with the transportation industry to improve processes, create products and markets, and lead the way to cost-effective transportation solutions, which in turn lead to a healthier economic future.

By working with Argonne through various types of cost-sharing arrangements, companies can jump-start their efforts to develop the next generation of transportation technologies without shouldering the often-prohibitive cost of initial R&D alone. Argonne has participated in dozens of these partnerships and has even been involved in helping to launch start-up companies based on the products and technologies developed here.

If working with world-class scientists and engineers, having access to state-of-the-art user facilities and resources, and leveraging your company's own capabilities sound like good business opportunities to you, please contact our Office of Technology Transfer and see how we can put our resources to work for you.

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